

A New Species of Platycystites (Echinodermata: Paracrinoidea) From the Middle Ordovician of Oklahoma

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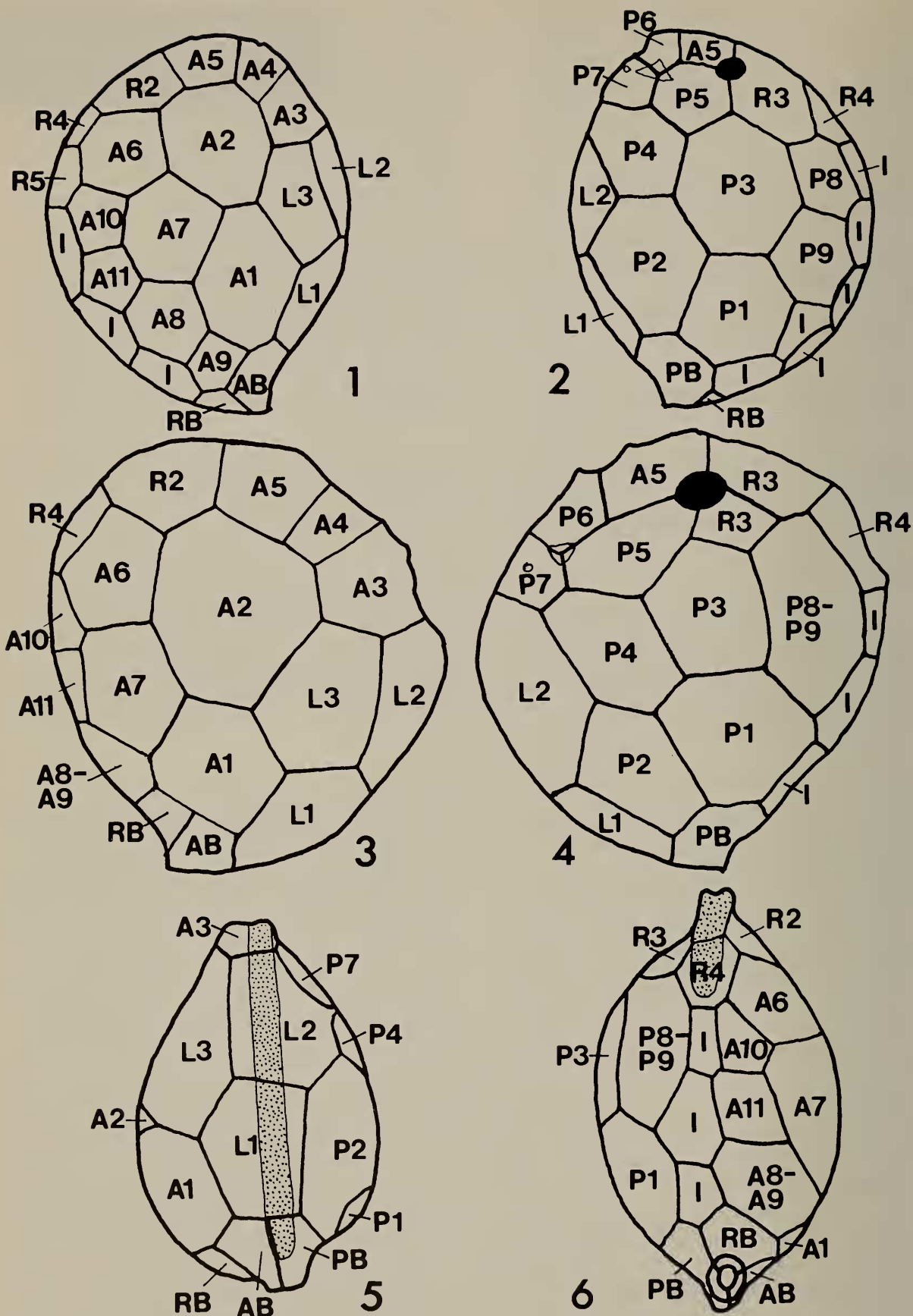
ABSTRACT

The paracrinoid *Platycystites infundus*, new species, from the Bromide Formation (Middle Ordovician) of Oklahoma provides additional evidence that at least some paracrinoids lay upon the substrate or partially embedded on it. The inferred mode of life, based on stem attachment and thecal morphology, of the 3 species now ascribed to *Platycystites* suggests that only 1 (*P. faberi* Miller) was held erect above the sea bottom by its column.

The rare paracrinoid genus *Platycystites* (Order Platycystitida Parsley and Mintz, 1975) is presently known only from southwest Virginia, northeast Tennessee, and southern Oklahoma. Like most other paracrinoids it is restricted to rocks of Middle Ordovician (Blackriverian) age. *P. faberi*, type species of the genus, was inadequately described and illustrated by Miller (1889), who also presented incorrect occurrence data for the species. No further species were added to the genus until Bassler (1943) proposed several new species (*P. bromidensis*, *P. cristatus*, *P. fimbriatus*, *P. levatus*), all from the Bromide Formation (?Chazy-Blackriverian) of Oklahoma. Another Bromide species (*P. bassleri*) was added by Sinclair (1945).

Though the distinctness of the genera now grouped in the Paracrinoidea had long been recognized, the group was not raised to class status until 1945 (Regnell, 1945). By far the most com-

prehensive treatment of the paracrinoids is that of Parsley and Mintz (1975). In their paper they redescribed and reillustrated *P. faberi* and reduced all of the Bromide species into synonymy with *P. cristatus* Bassler. Apparently all of the Bromide specimens studied by Bassler and Parsley and Mintz came from the lower echinoderm zone (informally designated the "*Platycystites* zone") of the Mountain Lake Member, in which *Platycystites* is prolific. The total thickness of the beds through which *P. cristatus* ranges is about 65 ft, but all are from the lower part of the Mountain Lake (Parsley and Mintz, 1975: 74). The single specimen described herein as *Platycystites infundus*, n. sp., was collected by McGinnis from an exposure of the upper echinoderm zone (of Fay and Graffham, 1969: 37-42) which occurs at the top of the Mountain Lake, considerably above the "*Platycystites* zone." The echinoderm fauna of this unit (informally termed the



Figs. 1-6.—Plate diagrams of *Platycystites*. 1, 2, Anterior and posterior views of *P. cristatus* (modified from Parsley and Mintz, 1975, text-fig. 3); 3-6, anterior, posterior, left, and right views of holotype of *P. infundus*. A-anterior plates; AB anterior basal; L, left plates; P, posterior plates; PB, posterior basal; R, right plates; RB, right basal. Periproct black; positions of gonopore and hydropore indicated by light lines.

"*Oklahomacystis* zone") differs considerably from that lower in the Mountain Lake. The paracrinoid genera *Oklahomacystis* and *Sinclairocystis* have not been found outside the zone and appear to be endemic to this unit. A single specimen of *Platycystites* has been collected from the *Oklahomacystis* zone at a locality near Sulphur, Oklahoma; the specimen lacks the arms and stem but it is preserved as well as are most paracrinoids. This part of the Bromide is not well exposed and the source exposure is no longer collectible: J. Sprinkle (pers. comm., 1976) reports that around 45 specimens, possibly referable to *P. faberi*, have been collected from this zone in the western Arbuckle Mts. (Oklahoma). None of these apparently are referable to either *P. cristatus* or *P. infundus*, n. sp.; hence it is unlikely that any additional specimens of *P. infundus* will be discovered in the near future. Despite its imperfections, the specimen preserves most important morphological features and is clearly a distinct species.

The addition of a third species to *Platycystites* necessitates some reevaluation of the functional morphology of the genus. In particular the thecal shape and position of the stem facet of *P. infundus*, n. sp., support the contention of Durham (in Parsley and Mintz, p. 69, figure 6) that at least some species of this genus were recumbent upon or partly buried in the substrate with the stem acting as an anchor or as a tether rather than serving to elevate the theca above the sea bottom as Parsley and Mintz (*op. cit.*) envision it. Nevertheless, we have used Parsley and Mintz's descriptive terminology and orientations which are partly predicated on the assumption that their reconstruction of the living position of *Platycystites* is correct. The system they employ facilitates homologous comparisons between the genus and other paracrinoids, particularly within the *Platycystitida*. It can be applied with little modification to *P. infundus*. Its use does not, however, imply acceptance of

their interpretation of the genus' mode of life.

Higher classification of many of the poorly known fossil echinoderm classes is currently in a state of flux. As regards the Paracrinioidea we have followed the taxonomy of Parsley and Mintz through the ordinal and class levels but refrain from assignment of the class to a subphylum. Parsley and Mintz (1975: 5-7, 25-26) erected the subphylum Paracrinozoa, with the single class Paracrinioidea, for this distinctive group of echinoderms because, according to these authors, the paracrinoids cannot be placed in either the Crinozoa (Matsumoto, 1929) or Blastozoa (Sprinkle, 1973). Briefly the justification for this action is that the Paracrinioidea "have characteristics that fit into both subphyla mentioned above and they also have traits which are peculiar to their own subphylum, e.g. internally opening transutural slits, left lateral offset peristome relative to the column, along with a pronounced plate increase in the right lateral margin and bilateral symmetry defined by the G plane" (*op. cit.*, p. 26). While these characters collectively discriminate the Paracrinioidea from other echinoderm classes, none of them individually are unique to it. Some features of the paracrinoid thecal plate pore system are strikingly reminiscent of those of eocrinoids; more detailed analysis of it is required to establish its uniqueness, particularly since one order of Paracrinioidea (*Platycystitida*) totally lacks a pore system. Bilateral symmetry defined by the G plane is also developed in some Rhombifera (e.g. *Pseudocrinites*; see Paul, 1967 and Kesling, 1968 for discussion). Lateral offset of the peristome also occurs in other groups; examples include *Columbocystis* (uncertain affinities) and the diploporid cystoid *Alloccystites* (Parsley, 1975: 356-357).

The validity of the subphylum Blastozoa Sprinkle has recently been questioned by Breimer and Ubaghs (1974a), and Breimer and Macurda (1972) and Macurda (1973) have presented mor-

phologic data indicating the presence of tube feet in the Blastoidea, *contra* Sprinkle. Without attempting to evaluate the merits of the various points raised by these authors, it is fair to say that a consensus has not yet emerged. The basic data required to establish which characters are of importance at the highest levels of echinoderm taxonomy are still largely lacking. While quite recently major essentially solid taxonomic contributions such as those of Parsley and Mintz (1975) and Sprinkle (1973) have greatly clarified the status of a number of puzzling fossil echinoderms, it seems reasonable to expect that the current information explosion in the study of primitive echinoderms will continue for some time. Consequently we feel that large scale rearrangements of the echinoderm classes and, particularly, a proliferation of subphyla are premature. We follow Parsley and Mintz (1975) and Breimer and Ubags (1974b) in removing the Paracrinoidea from the Crinozoa, but like the latter authors do not place it in a subphylum. We admit the strong possibility that the Paracrinozoa of Parsley and Mintz may eventually prove fully acceptable to most workers.

Systematic Description

Class PARACRINOIDEA Regnell, 1945

Order PLATYCYSTITIDA Parsley and Mintz, 1975

Diagnosis.—"Paracrinoids without sutural pores; arms epithelial, typically branched; thecal plates generally smooth with pustulose prosopon" (Parsley and Mintz, 1975: 57).

Family PLATYCYSTITIDAE Parsley and Mintz, 1975

Diagnosis.—Theca ovoid to amygdaloid in shape with approximately 27 plates identifiable in juveniles, plus a variable number of intercalates along the right side (some are generally present). Arms 2, transverse, primarily epithelial (adopted from Parsley and Mintz, 1975: 58).

Genus PLATYCYSTITES Miller, 1889

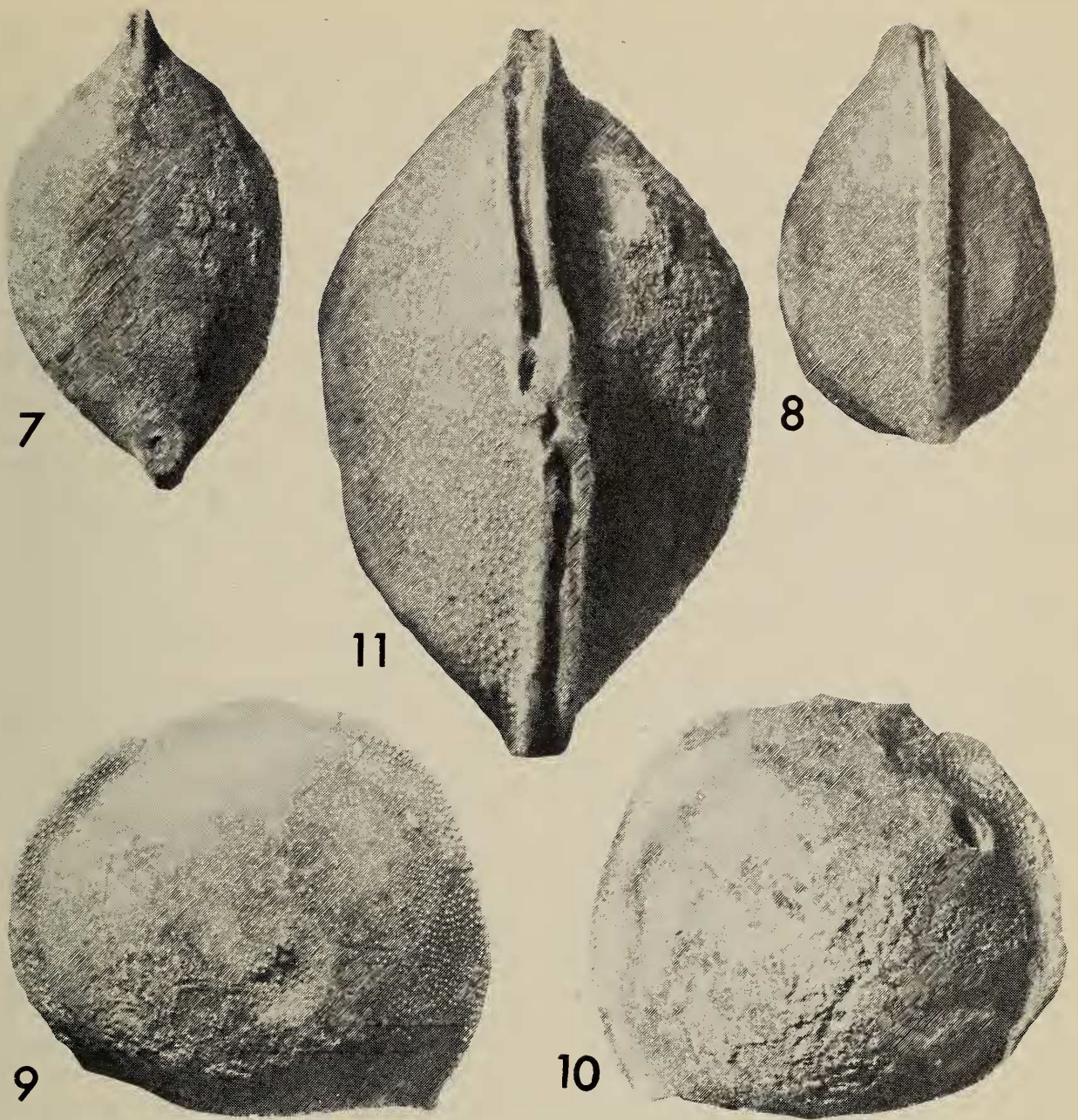
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- 1975. *Platycystites* Miller, Parsley and Mintz, Bull. Amer. Pal. 68(288): 59.

Diagnosis.—Theca amygdaloidal, compressed to broadly oval and inflated in cross section, with 27 to 29 identifiable plates; some species with additional intercalates along right lateral margin; maximum number of plates about 47. Peristome usually only slightly offset to left, periproct on posterior face near upper margin. Arms 2, epithelial, extending varying distances along the lateral margins (modified from Parsley and Mintz, p. 59).

Type species.—*Platycystites faberi* Miller, 1889.

Range.—Middle Ordovician (Blackriverian); Bromide Formation, Oklahoma; Ottosee-Benbolt, Virginia and Tennessee.

Remarks.—Our generic diagnosis differs only slightly from that of Parsley and Mintz; the main difference is that we do not recognize the presence of intercalates in the type species. Our interpretation of thecal plating in *P. faberi* will be presented in a forthcoming paper. For convenience the theca is oriented in the plate diagrams with the periproct uppermost and the stem roughly opposite the periproct defining a vertical longitudinal axis. This orientation is not identical, in the opinion of the authors, to that of the whole animal in life position except possibly in *P. faberi*. Thecal plate nomenclature and face terminologies



Figs. 7-11.—Holotype of *Platycystites infundus*, n. sp.; 7-10, views of right, left, posterior, anterior sides, all magnified $\times 2.7$ (9 and 10 are side views in presumed life orientation); 11, top view, centered on peristome in presumed life orientation, $\times 4.0$.

are those of Parsley and Mintz as summarized in their text-figure 3 (*ibid*, p. 60; compare the explanation of our figs. 1-6) except in minor details. The terms right and left are defined relative to the posterior face when the theca is viewed in anterior-posterior profile as in fig. 2 and 4.

***Platycystites infundus*, n. sp.**

Figures 3-11

Diagnosis.—Theca with about 33 plates, few intercalates, not strongly inflated. Arm calluses

prominently developed, left arm nearly reaching column. Theca strongly asymmetric, right side flattened. Stem facet directed toward right.

Material.—One specimen, holotype SUI 39513, from the "Oklahomacystis zone," top of the Bromide Formation, Mountain Lake Member, 1.8 mi. Sulphur, Oklahoma.

Description.—Theca unevenly rounded in anterior-posterior profile; largest dimensions subequal, length of holotype 22.0 mm; maximum width of holotype 21.7 mm. Total number of thecal plates about 33; few of these are intercalates (3 on holotype). Theca flattened along right side, evenly oval in outline when viewed along a plane normal

to axis through gonopore and hydropore and center of right side (fig. 11). Stem facet elliptical, not crenulate, narrow, width 2.1×2.0 mm, oriented parallel to proximal distal axis. Lumen small, round, diameter 0.7 mm.

Basals 3, unequal; PB and AB large, equal in area, developed on posterior and anterior faces and left margin of theca. RB short, much smaller in area than PB or AB, making up less than one-third of column attachment facet. Left plates 3: L1 and L2 crossing thecal margin; L1 situated immediately above PB and AB, hexagonal, crossed transversely by left arm, developed more on anterior face; L2 above L1, 6-sided, arm callus traversing the plate along its long axis, most of plate area on posterior side. L3 to left of other left plates, pentagonal, wholly on anterior face.

The 10 anterior plates plus the left plates make up most of the anterior thecal face (figs. 3 and 9). Subcentral on the anterior face is the large A2, bordered by 8 plates. Immediately beneath A2 is A1, a heptagonal plate that frequently is the largest anterior thecal element in *P. cristatus* (Parsley and Mintz, p. 62) but in this species is considerably smaller than A2. A6 and A7, subequal in area, border A2 on the left; A6 is nearly equally 5-sided; A7 is irregularly hexagonal. Most of the left anterior border is made up of 3 small plates (A10, A11, A8–9) which do not extend more than half way around the left side of the theca. A10 and A11 are small and unequally pentagonal; the single plate presumed to represent A8 and A9 in *P. cristatus* (fig. 1) is heptagonal and adjoins A11 and RB laterally along the lower left anterior margin. Adoral to A10 is R4, a small hexagonal element visible on both sides of the theca and bisected by the right arm seat which terminates on this plate (figs. 6 and 7). No plate corresponding to R5 of *P. cristatus* is present on the holotype of *P. infundus*. R2, plus anteriors A3, A4, and A5 fill out the upper margin of the anterior face. These plates are quite small in *P. cristatus*; they are larger in area in this species, presumably because of the more extensively protruded arm tracks. A2 and A3 are pentagonal; their upper edges terminate on the anterior face, as does that of the small 4-sided A4. A5 is equally developed on both faces; this plate forms the northwest quadrant of the periproct border on the posterior face.

The periproct, located near the upper margin on the posterior face, is surrounded by 4 plates, each of which subtends an equal area of its border. The right half of the periproct border is formed by R3, which is bipartite; A5 and P5 also contribute to the periproct border. The periproct opening itself is raised slightly and circular (diameter 2.2 mm). A presumed hydropore is located at the junction of P5, P6, and P7; the opening itself cannot be seen, but it is likely situated on the small raised triangular platform visible where these 3 plates meet (figs. 4, 10). A small round pore (gonopore), central on a raised

tubercle, occurs on P7. All plates along the upper margin of the posterior face are elongated parallel to the thecal margin. Between R3 and PB the right posterior margin is made up of R4 and 3 small intercalates. Distal to P7 the left posterior margin is defined by L2, L1, and PB. L2 passes over onto the anterior face but is mostly posterior in position. The central area of the face is occupied by relatively few, large plates, i.e., P1–P5 and P8–9. P1, the largest posterior plate, and P4 are hexagonal; the pentagonal P2 and P3 are subordinate in size to P1 and P8–9 in this species (compare *P. cristatus*, fig. 2). The elongate irregular shape of P8–9 is unusual; this plate may be abnormal in this specimen and more usually 2 discrete elements may be present as in *P. cristatus*.

Calluses for the epithecal arms are narrow (average width 1.1 mm) but prominently extended out from the theca throughout their length (figs. 9–11). The left arm extends around the theca to about the midheight of PB before becoming exothecal or terminating. The right arm callus does not extend below R4. None of the arm plates themselves are retained. The proximal part of the left arm callus, and nearly all of the right arm, is invaginated into the theca, forming a trough. Proximal to the oral opening the troughs appear to penetrate the bottom of the callus, which is thus open to the interior. The thecal plates, except in the areas making up the arm calluses, are covered with a fine pustulose prosopon. The column is unknown.

Derivation of name.—The specific epithet refers to the presumed life habit of the species (*infundus*, laid out upon, spread on).

Remarks.—*Platycystites infundus*, n. sp., differs from *P. cristatus* in a number of ways as noted above; but given the limited material on which *P. infundus* is based and the small number of described *Platycystites* species, the value of many of the noted features of the holotype as taxobases on the specific level is uncertain. Only *P. cristatus* is known from a reasonably large number of specimens and has been described at length. A definitive plate diagram of *P. faberi*, together with detailed descriptions of thecal plate identities and locations based on a large series of specimens, would facilitate platycystitid taxonomy but such a series is unlikely to be available in the near future. In their absence the following discussion is based primarily on *P. cristatus*.

Some degree of variation in thecal plate

number has been noted by Parsley and Mintz (*ibid.*, p. 73) in *P. cristatus*; most variable is the number of intercalates, which can range between 2 and 17 in this species. The other thecal plates are less variable; their number is largely independent of thecal size (height), they are in more or less fixed position, and, though their outline may vary, they are readily identifiable from specimen to specimen (*ibid.*, p. 60). It is hence possible that many of the deviations from *P. cristatus* noted in the description of *P. infundus* (e.g. bipartite R3, combined A8–9 and P8–9, R5 missing or combined with R4) may be significant at the specific level. On the other hand, some of these variations could also occur on an abnormal specimen, but when combined with other noted differences they may be utilized with more confidence. Possibly some of these features are related to life habit. Paired small plates (*i.e.*, A10 and A11, A8 and A9, P8 and P9 in *P. cristatus*) may have originated through bisection of what was originally a single element. Replacement of a single plate (normal condition for the population) by 2 elements in some individuals is known in some Rhombifera: Paul (1966, 1968) figures 2 examples of such arrangements in *Glansicystis baccata* (Forbes). A specimen of *P. faberi* in the University of Iowa collection (SUI 39514) also has combined A10–11 and A8–9 into single plates. If *P. faberi* represents the more primitive platycystitid form, then the apparent increase in number of major thecal elements in *P. cristatus* and *P. infundus* may be both a phenotypic and genotypic response to a changed life habit (*i.e.* recumbent versus erect theca). In the 3 known species of *Platycystites* there is a direct correlation between the number of thecal plates and the degree of thecal inflation; the highly inflated *P. cristatus* has the largest number of regular and intercalate plates while the compressed *P. faberi* has the least of both. As might be expected *P. infundus* has intermediate numbers of both plate types.

Many of the differences in plate proportions between the 2 species may similarly be interpreted as due to individual variation rather than as valid specific features. Some undoubtedly result from unlike thecal outlines. Gross shape varies somewhat from individual to individual in *P. cristatus* but is a useful taxobasis if used cautiously. The holotype of *P. infundus* falls outside the normal range of variation of *P. cristatus* as regards thecal shape. Probably the greater area of the upper marginal plates in *P. infundus*, which is related to the degree of extension of the arm tracks, is also not simply a feature of this particular specimen. The flattening of the right side of the holotype of *P. infundus* is not due to distortion but appears to be an original feature. We believe that it served to stabilize a theca which was recumbent on the sea bottom; in fact the fossil specimen is stable at rest in the position illustrated in figs. 9 and 10. The orientation of the stem facet, which is diametrically opposite to that of *P. cristatus*, (compare figs. 2 and 4) is consistent with this interpretation. Other points of difference between the 2 are likely of minor importance or cannot be evaluated on the basis of present material. *P. infundus* has a coarser pustulate prosopon on the plate surfaces than typical *P. cristatus*; but similar specimens of the latter have been observed. The small number of intercalates in *P. infundus* could be an artifact of limited material; we believe, however, that this feature is specific to the species. With its flat right side and less expanded theca (*P. cristatus* is greatly inflated in this area) there is less need for extra thecal elements.

Altogether we feel that there are enough points of difference of significance to justify the separation of the “*Oklahomacystis* zone” specimen from *P. cristatus* at the specific level in spite of the lack of a large group of similar specimens. In terms of gross thecal morphology and plate arrangement, *P. infundus* is closer to *P. cristatus*

than to *P. faberi* and has most likely evolved from the former species.

Functional Morphology

Two current interpretations of the life habit of Paracrinoidea (and *Platycystites*) have the theca strongly canted to the right, with the peristome uppermost and the tips of the epithecal arms defining a plane parallel to the substrate surface. Parsley and Mintz (*ibid.*, p. 22) believed that the theca was raised off the sea bottom by the stem, which would have been relatively rigid. Conversely, Durham would place the near horizontal arm termination plane at the sediment-water interface. In this model the theca would be partly buried with the possibly distally flexible stem serving as a sub-surface anchor (*ibid.*, p. 22, test-fig. 6). A third possibility is that the paracrinoid stems were "runners" somewhat in the manner of calceocrinids with the theca lying on the substrate surface, peristome uppermost, tethered by its stem. Parsley and Mintz's interpretation is most plausible for the majority of paracrinoids which are not strongly asymmetric. For genera like *Platycystites* we believe that Durham's hypothesis is more plausible. The addition of *P. infundus* to the genus provides some additional information on *Platycystites* mode of life.

In their discussion of *Platycystites* Parsley and Mintz (*ibid.*, p. 69) considered *P. faberi* and *P. cristatus* collectively, as though both were functionally and morphologically identical: actually they have quite different morphological features. The restoration of *P. cristatus* which they illustrate (*ibid.*, text-fig. 6), reflecting the opinion of J. Wyatt Durham on its living position, is probably most nearly correct for this species and for *P. infundus*, but it very likely does not apply to *P. faberi*. The situation in *Platycystites* might be more complex than visualized by previous authors.

P. faberi has a thin compressed pear-shaped theca with the peristome and columnar attachment area forming a

vertical axis. Both the right and left epithecal arms extend from the mouth to, or nearly to, the column. The animal was almost perfectly bilaterally symmetrical and was no doubt held above the substrate on a column. No complete specimens are known; hence it is not possible to determine with certainty whether or not the theca was canted by a flexure of the proximal column as Parsley and Mintz (*ibid.*, text-fig. 1) illustrate for *Amygdalocystites florealis* and infer for most paracrinoids. We believe that the horizontal plane defined by the arm terminations reflects the living orientation in all paracrinoids; we suspect that the theca of *P. faberi* was not canted and that the supporting column continued from its junction with the theca, unbent proximally and aligned with the longitudinal axis of the theca. Like the theca, the column of *P. faberi* was probably usually upright and vertical. In this position the periproct would be offset slightly to the right of the peristome while the peristome, gonopore, and hydropore would be uppermost. The periproct would thus be at a slightly lower level than the peristome and associated thecal openings, thus tending to remove anal wastes from its vicinity. It is difficult to conceive of any manner in which fouling of the subvective appendages could be avoided if the theca of *P. faberi* were in contact with or partly buried in the substrate.

P. cristatus and *P. infundus* have modified the theca to a strongly asymmetric shape. *P. cristatus* is greatly inflated on the right side proximal to the column; this area of the theca is broadly rounded. The equivalent thecal surface in *P. infundus* is flattened and the theca is not as rounded in profile. As noted by Durham (in Parsley and Mintz) the right arm of *P. cristatus* is always short and does not extend into the expanded area proximal to the column which is presumed to contact the sea floor; the right arm track of *P. infundus* is similarly limited. Conversely, in both species the left arm, which would be above the sea floor in Durham's and our reconstruc-

tion, extends nearly the full length of the left side of the theca; in some specimens it may even extend onto the column. These features are shared with *Amygdalocystites florealis*, which also may have had the theca in contact with the substrate. Possibly the same 2 modes of living postulated for *Platycystites* had their equivalents in *Amygdalocystites*: most species, like *A. florealis*, have a bend in the column proximal to the theca, but the poorly known *A. radiatus* appears to lack it (Parsley and Mintz, p. 51). An undescribed species of *Amygdalocystites* from the Dunleith (Middle Ordovician) of northern Iowa, currently being studied by T. W. Broadhead (University of Iowa), has a proximally unflexed column and 2 long equal epithecal arms. Its thecal shape is similar to that of *P. faberi* and its life habitus was probably comparable. If the erect life orientation suggested by Parsley and Mintz were correct and universal within these 2 genera we see no reason why both arms in all species should not be equal in length. It is probable, in our opinion, that major differences in thecal symmetry within a genus reflect differing life habits, especially if modifications of symmetry correlate with other morphological changes. A thecal morphology and arm arrangement comparable to that of *P. faberi* is present in other echinoderm classes; at least 1 similarly-shaped rhombiferan (*Pseudocrinites*) has 2 recumbent ambulacra extending down the theca onto the column. The Parsley and Mintz model would, we feel, require the column to be strong and relatively rigid throughout its length; however complete columns are exceedingly rare. Not uncommonly specimens of *A. florealis* and *P. cristatus* do retain the proximal flexed, presumably ankylosed, part of the column. This is more consonant, in our opinion, with Durham's model or with a bottom-runner life habit.

Pronounced asymmetry of the theca accompanied by a small column which may be bent abruptly backward next to the theca is not uncommon in other paracrinoids. According to Hudson

(1905) the stem of *Canadocystis emmonsii* "appears to have been short and used perhaps for an anchor, but not for complete support." Hudson further suggests that the ancestors of these paracrinoids "were once supported by the stem alone and had their arms in a normal position, but that descendants with weak stems often found themselves let down to the ocean floor and had to make shift to live under adverse conditions. Increased growth of the posterior side or decreased growth of the anterior plates would have brought the arms again uppermost to a form like that shown here." Allowing for differences in terminology and emphasis the theme of Hudson's observations is not far removed from our conclusions herein.

Durham (in Parsley and Mintz) believed that there was a discernable difference in prosopon below the supposed termination plane in some specimens of *P. cristatus*. We, like Parsley and Mintz, have been unable to detect this difference on the specimens we have examined; but this does not in our opinion weaken Durham's argument in any way. Other counterarguments advanced by Parsley and Mintz (p. 22) also do not seem compelling. Preserved columns of *Amygdalocystites* and *Platycystites* with the cited morphological features (proximal flexure and ankylosis) are quite short, and it is not surprising that they do not show a distal taper. *Comarocystites* undoubtedly has a holdfast and relatively long straight column and almost certainly was held erect; but this genus does not show pronounced thecal asymmetry or a differential expansion of one side of the theca. Holdfasts and lengthy stems have not been reported for *Platycystites* or *Amygdalocystites*. We do not believe that either Durham's model or that of Parsley and Mintz apply to all paracrinoids. If the Paracrinioidea is a valid taxon of class rank it would be surprising if one mode of living was adopted by all members; considering the morphologic diversity of the known paracrinoids this possibility becomes vanishingly small. Investigation

of each paracrinoid genus individually might yield more accurate information about the class' paleoecology than does the attempt to apply a single over-extended, albeit useful, model to the class *in toto*.

Information about the length of the entire column and the nature of the adult attachment device, if any, in *Platycystites* is lacking. It is worth noting, however, that a possible future find of a long column and holdfast in a species like *P. cristatus* would not necessarily invalidate Durham's hypothesis. The reconstruction in Parsley and Mintz shows an abrupt stem termination, but it is possible that the species was attached when young and lost the stem terminus as it approached maturity. Alternatively it is also possible that the theca merely lay on the surface of, rather than partly embedded in, the substrate. If such were the case the largely flexible stem, doubled back under the theca, would have served as a tether of a theca which could adjust its living position in a manner analogous to that suggested by Kesling and Sigler (1969) for the Calceocrinidae: in this model the length of the stem is irrelevant, and in fact calceocrinid stems shorter than the crown or many times its length have both been reported (Brower, 1966). Like Parsley and Mintz we postulate that many paracrinoids were rheophilic; our model, or a modification of Durham's, would give the animal a greater ability to adjust to a changing current regimen than would that of Parsley and Mintz. In either case the streamlined bilaterally symmetrical theca and concomitantly reduced subvective system are supportive of a rheophilic habit. Definitive evidence allowing the elimination of one or the other major alternative interpretations of living position has not yet appeared.

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Evolutionary and Paleoecologic Significance of Abnormal *Platycystites cristatus* Bassler (Echinodermata: Paracrinoidea)

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ABSTRACT

Two specimens of the common Bromide Formation (Middle Ordovician; Oklahoma) paracrinooid *Platycystites cristatus* Bassler have 3 epithecal arms instead of the normal 2. Analysis of the location and mode of branching of these specimens supports the suggestion of Parsley & Mintz (1975) that the paracrinooid ancestor had 2 epithecal arms. One specimen also has a portion of a column embedded in its right side; the column location and thecal shape indicate that the life position of the animal was with the theca recumbent on the sea floor.

Three-Armed *Platycystites cristatus*

The rare fossil echinoderm class Paracrinoidea (Regnell, 1945) exhibits considerable morphologic diversity despite its restricted range and distribution (Middle-Upper Ordovician, almost exclusively North American) and the small number of member taxa (9 genera) as presently known. Only 2 species, *Platycystites cristatus* Bassler and *Oklahomacystis tribrachiatus* (Bassler), are represented by large numbers of individuals. The class recently has been monographed comprehensively by Parsley & Mintz (1975). While their work was primarily a taxonomic treatment of North American paracrinooids they also briefly present some data bearing on the phylogeny of

the group (Parsley and Mintz, 1975: 11–15). Their tentative comments are based on the assumption that the so-called cystidean transverse arm pair is more primitive than the triradiate condition favored by some authors (Parsley and Mintz, 1975: 12, footnote). More particularly they infer that the primitive subvective condition in paracrinooids was also a primary transverse pair of epithecal arms, and that the exothecal, more-than-2-armed condition present in some genera of both paracrinooid orders is more advanced. Those genera which have more than 2 arms (e.g. *Oklahomacystis*) are believed to have acquired the extra subvective elements by branching of 1 or both members of the primary pair (Parsley and Mintz, 1975: 11).